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ENGINEERING DATA

REDUCTION GEAR
FOUNDATION BOLT TIGHTENING TORQUE AND CHOCKING RECOMMENDATIONS

Submitted by: The Falk Corporation

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THE FALK CORPORATION
Engineering Department

FOUNDATION BOLT TIGHTENING TORQUE AND CHOCKING RECOMMENDATIONS

Falk has received numerous requests for recommended foundation bolt tightening torque. The information should be provided by the shipyard or the company supplying the chocking material. However, when the information is not available from other sources, the following can be used as a guide for proper tightening torque. The data is based on meeting the following specifications:

1. Recommended Design for Steel Chocks

The gear case is to be supported and aligned on the foundation by means of fitted steel chocks.

1.1 The chocks should be a nominal 1.5" thick with stock allowed for fitting.

1.2 The bottom of the chock should be tapered 1/2" in 12" to aid in the insertion of the chock when fitting.

1.3 The chock area should be designed to be at least 6.5 times the root area of the foundation bolts. Thus, the compressive load on the chock will be a maximum of 3000 psi when the bolt tension is 19,500 psi (70% of the allowable yield stress for a Class 2 bolt).

The chock should be designed to carry an additional 2000 psi maximum compressive load due to the combined weight and live load.

1.4 All foundation bolts should be designed for a tensile stress of 10,000 psi maximum at the root area of the thread due to the live load on the bolt when the unit is operating at full service horsepower.

1.5 Fitted foundation bolts should be designed for a direct shear stress of 10,000 psi maximum.

See Figure 1

2. Recommended Design for Plastic Chocks

As an alternate to the use of steel chocks, poured resin chocks (Philadelphia Resin's CHOCKFAST Orange, 610 TCF, or better) may be used provided the following additional limitations are observed.

2.1 The chock area should be sufficient to limit the compressive stress to 100 psi maximum, based on the combined weight and live load at full service horsepower.

2.2 Bolt tightening torques should be set to result in an additional compressive stress of 400 psi maximum over the chock area.

2.3 The chock surface should be symmetrical about the foundation bolts. The chock area should be 40 times the nominal bolt cross-section area.

2.4 The combined tension and bending stress in fitted bolts should be limited to 20,000 psi maximum considering both tightening torque and live load.

2.5 Collision chocks should be installed to resist thrust in both directions where necessary. The stress in the weld section should not exceed 5000 psi maximum.

2.6 Shear stress in chock material should not be considered in calculating the capacity of foundations carrying thrust load. Where necessary, steel filler chocks reamed to the foundation bolts can be used to limit bolt spans and reduce bending stress due to thrust. Filler chock width should engage at least two foundation bolts and be oriented in a fore and aft line. An approximate 0.5 inch gap should be left to assure resin filling under the foundation. Weld filler chock fore and aft before reaming. See Figure 2.

2.7 The recommended minimum chock area under each bolt is 20 square inches.

2.8 The chock may engage more than one foundation bolt, but the chock length should not exceed 30 inches.

2.9 Chock thickness should be at least 0.5 inch, but should not exceed 1.5 inches.

2.10 Where alignment or contact adjustments are required, a steel soleplate may be imbedded into the chock surface to permit shimming. The soleplate must meet the requirements of 2.3. The soleplate may only be used with clearance bolts. It is not to be used at thrust bearing foundations. See Figure 3 for a typical soleplate design.

3. Foundation Design Recommendations

A supporting structure capable of withstanding the weight, thrust, and torque reactions of the gear unit must be provided.

3.1 It is recommended that mounting surfaces be finish machined if fitted steel chocks are used.

3.2 Sections at the mounting surfaces should be greater than 0.5 times the foundation bolt diameter. Where fitted bolts are used with plastic chocks for thrust loads, the sections should be at least 1.0 times the bolt diameter.

3.3 The mounting surfaces should be at a height to allow for the insertion of nominal 1.5" thick chocks for the proper alignment of the gear unit.

3.4 The mounting surfaces should be flat and sloped 1/2" per foot toward the access points for easy insertion of steel chocks.

3.5 Mounting surfaces may be level where plastic chocks are used.

4. Design of Foundation Bolts

Units are designed for use with SAE Grade 2, low carbon steel foundation bolts to be furnished by the shipbuilder.

4.1 Where the bolt it not required to carry a thrust load, bolts having a nominal clearance dependent on size of bolt are recommended.

4.2 Where the bolt is required to carry a thrust load, a fitted bolt is required.

4.3 When used with steel chocks, it is recommended that all bolts should be tightened so that the bolt tension is approximately 70% of the allowable yield stress.

4.4 When plastic chocks are used, fitted bolts will be subject to bending stresses. The tightening rorque must be reduced so that the combined tension and bending stress will not exceed 20,000 psi. The combined stress may be calculated by the following equations:

$$S_b = \frac{16PL}{\pi D^3}$$

$$S_B = \frac{16\ P}{3\pi D^2}$$

$$S_T = \frac{4\ T}{\pi\ D^2}$$

$$S_{max} = \frac{S_b + S_T}{2} + \sqrt{\left(\frac{S_b + S_T}{2}\right)^2 + S_B{}^2}$$

where:

S_b = bending stress (psi)
S_s = shear stress (psi)
S_T = tensile stress (psi)
P = thrust load per bolt (lb.)
T = bolt tension (lb.)
L = chock thickness (in.)
D = bolt diameter (in.)

4.5 The minimum allowable bolt tightening torques for plastic chocks are given in Table 1, Column A. These correspond to a tensile stress of 6720 psi.

4.6 If the plastic chock thickness is less than 0.75 times the bolt diameter (3/4 d), and are subject to a shear load of less than 4000 psi, they may be torqued to the values listed in Table 1, Column C.

4.7 In all cases, jam nuts must be furnished to prevent loss of bolt tension.

5. Installation of Poured Chocks

5.1 The chocks are to be poured under the supervision of the resin manufacturer, or using the guidelines presented in Section 5 "Installation of Poured Chocks"

5.2 The ambient temperature must be between 55°F and 100°F.

5.3 The alignment of the unit should be high by 0.001 times the chock thickness to allow for chock compression.

5.4 Surfaces should be free from grease, oil, rust and scale.

5.5 All wetted surfaces should be sprayed with release agent (except for soleplates which may be allowed to bond to the chock).

5.6 The jackscrews supporting the unit should be liberally gressed or wrapped in neoprene tubing to prevent bonding to the chock.

5.7 The bolt holes should be filled with neoprene or wooden dowels.

5.8 The chocking material is then mixed, carefully following the manufacturer's instructions, and taking care not to churn air bubbles into the mixture.

5.9 External heat should not be applied to speed the curing process, as localized heating may alter the machinery alignment.

5.10 No load may be applied to the chocks until they are properly cured. The chocks may be tested for proper cure by cutting an exposed edge with a find hacksaw blade held lightly. When the blade cuts cleanly, without binding, the chock is properly cured.

TABLE 1

TIGHTENING TORQUE FOR FOUNDATION BOLTS

Nominal Thread Diameter and Threads per Inch	Tightening Torque in Pound-Feet Non-Lubricated Thread		
	A	B	C
1 - 8 UNC	65	180	90
1-1/8 - 7 UNC	90	255	130
1-1/8 - 8 UN	95	270	135
1-1/4 - 7 UNC	125	360	185
1-1/4 - 8 UN	130	375	190
1-3/8 - 6 UNC	165	480	240
1-3/8 - 8 UN	180	525	265
1-1/2 - 6 UNC	220	630	320
1-1/2 - 8 UN	235	680	350
1-5/8 - 8 UN	310	900	455
1-3/4 - 5 UNC	345	1000	505
1-3/4 - 8 UN	395	1140	575
1-7/8 - 8 UN	485	1400	715
2 - 4-1/2 UNC	515	1500	765
2 - 8 UN	596	1730	880
2-1/4 - 4-1/2 UNC	755	2190	1130
2-1/4 - 8 UN	855	2480	1280
2-1/2 - 4 UNC	1035	3000	1550
2-1/2 - 8 UN	1190	3450	1785

A - Minimum allowable tightening torques for fitted or clearance bolts used with plastic chocks.

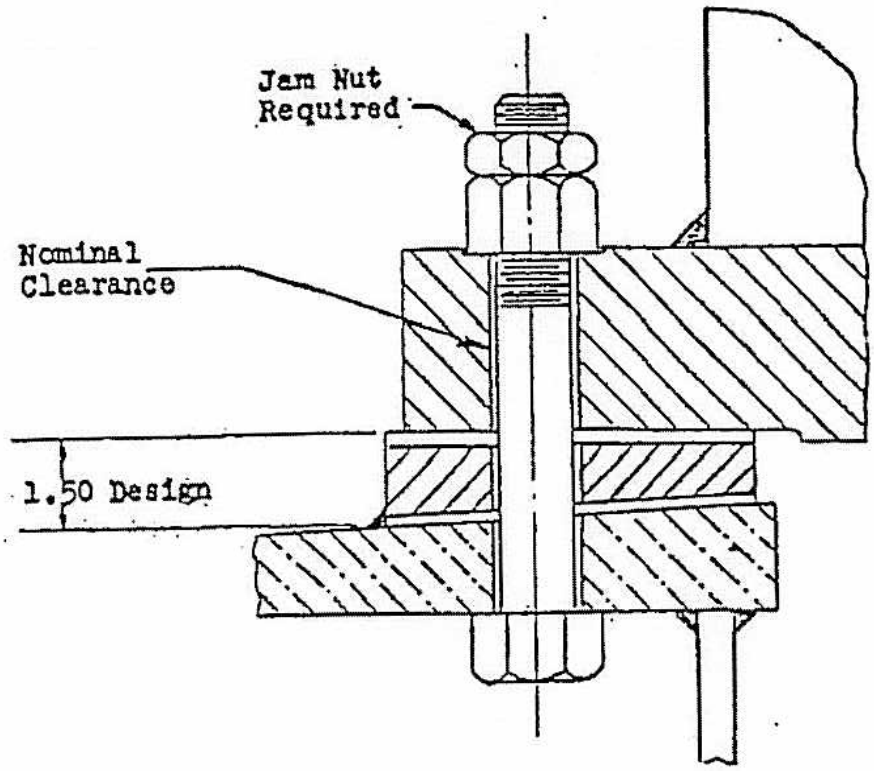
B - Recommended torques for all steel chocks and plastic chocks with clearance bolts.

C - Recommended torques for plastic chocks with fitted bolts. See paragraph 4.6 for restrictions.

NOTE! If bolt or nut is liberally coated with SAE 20 or heavier oil, multiply values listed above by 0.67.

DRS/rjr

STEEL CHOCKS



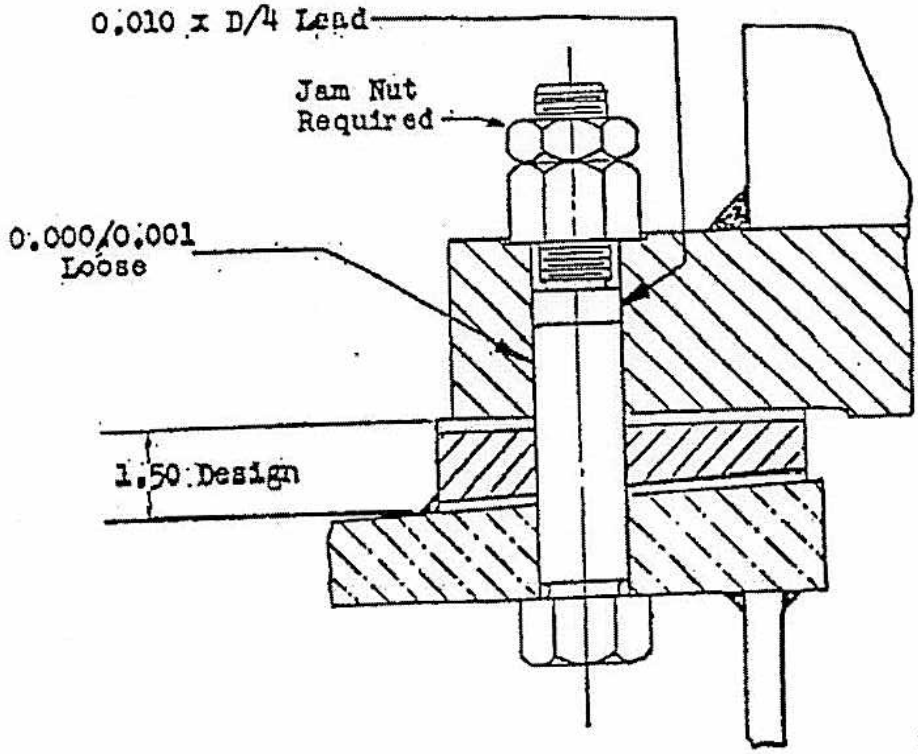


FIGURE 1

PLASTIC CHOCKS

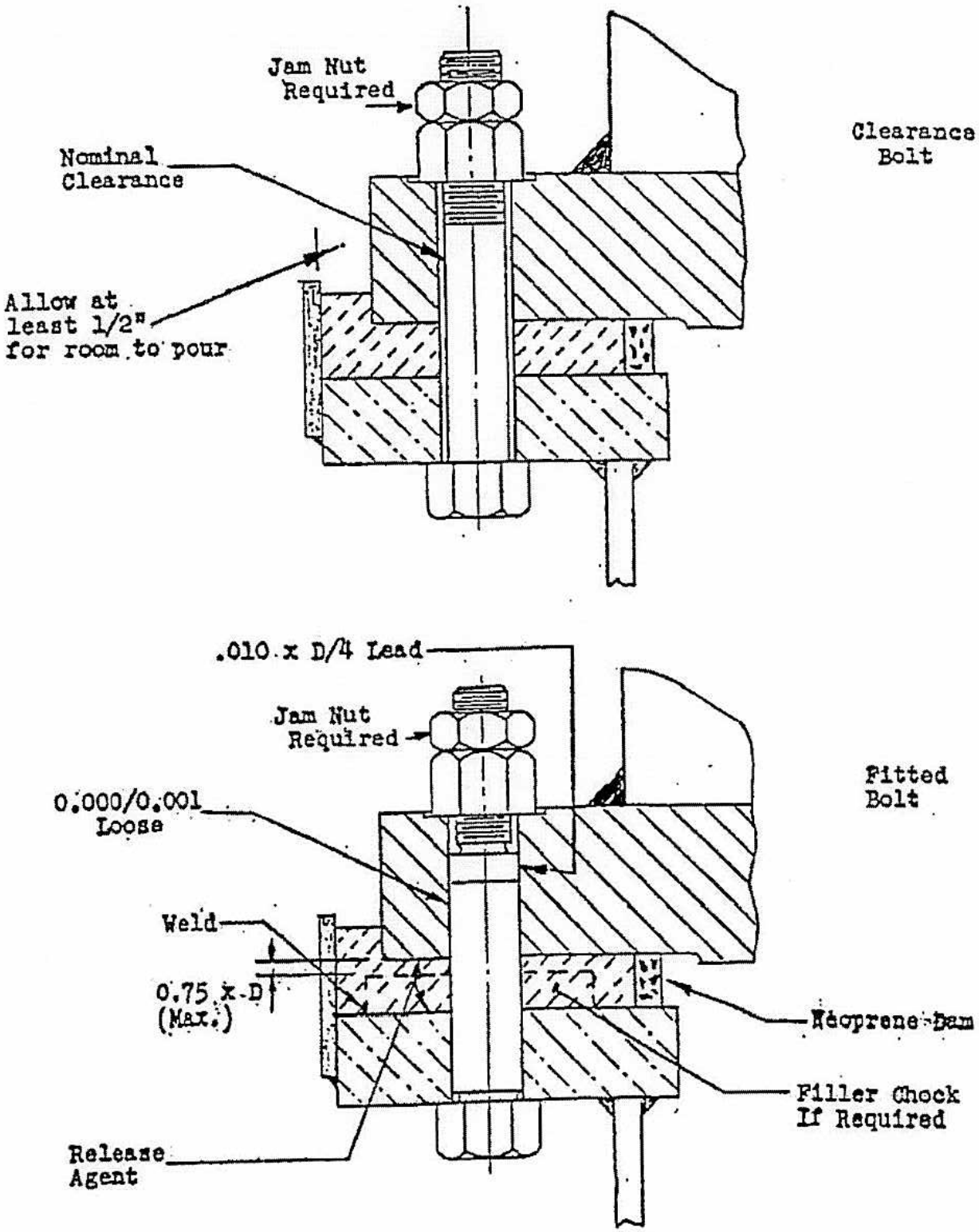


FIGURE 2